BULLETIN

OF THE INSTITUTE OF METALS

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INSTITUTE NEWS

Spring Meeting, London, 29–31 March 1960

As previously announced, the Institute's Spring Meeting will be held at Church House, London, from Tuesday to Thursday, 29–31 March.

The attention of members is particularly directed to the installation of the new President, Sir Ronald PRAIN, O.B.E., Hon. M.I.M.M., and his Presidential Address on "Mineral Resources and Metal Reserves" on the morning of Tuesday, 29 March; the May Lecture by Professor P. M. S. BLACKETT, M.A., Hon. D.Sc., Hon. LL.D., F.R.S., on "The Magnetism of Rocks and Continental Drift" on the evening of that day; a visit to the Victoria and Albert Museum; an informal Conversazione and Exhibition at the Institute's Headquarters on the Wednesday evening; and, in particular, the Annual Dinner on 31 March.

The Institute is honoured to have as its principal guest at the dinner, the Prime Minister, who will propose the toast of "The Institute of Metals and the Non-Ferrous Metal Industries". A circular letter, with reply form, regarding the dinner has already been sent to members in Europe, and it is hoped that there will be a very large attendance.

Discussions on some interesting and important scientific and technological themes have been arranged, and it is hoped that the meeting will attract many members with varying interests.

Visitors will be welcome at the Presidential Address, the May Lecture, and the scientific sessions, for which tickets are not required. Members' guests will also be welcome at the dinner, conversazione, and visit to the museum, for all of which tickets are required.

For the convenience of members, the Bishop Partridge Hall at Church House has been reserved as an additional cloak room; the Secretary's office will be in Committee Room 6. All rooms are on the first floor.

A detailed printed programme, with reply form, has been sent to all members resident in Europe. Other members who require copies are requested to apply for them.

PROGRAMME

Tuesday, 29 March

Morning

Location: *Church House, Great Smith Street, London, S.W.1 (Hoare Memorial Hall).*

10 a.m. *Annual General Meeting:*

(a) Report of Council for the Year Ended 31 December 1959.

(b) Report of the Honorary Treasurer for the Financial Year Ended 31 August 1959.

(c) Announcement of election of officers.

(d) Vote of thanks to the retiring officers.

(e) Installation of the New President, Sir RONALD PRAIN, O.B.E., Hon. M.I.M.M.

(f) Vote of thanks to the retiring President (Mr. G. L. BAILEY, C.B.E., M.Sc., F.I.M.).

11 a.m. approx. (g) Presidential Address by Sir RONALD PRAIN on "Mineral Resources and Metal Reserves".

(h) Presentation of Institute Medals:

(1) The Institute of Metals (Platinum) Medal to Professor ROBERT FRANKLIN MEHL, B.S., Ph.D., D.Sc., D.Eng.

(2) The Rosenhain Medal to Professor NORMAN JAMES PETCH, B.Sc., Ph.D., B.Met.

(3) The W. H. A. Robertson Medal and Premium (to be announced later).

Afternoon

Location: *Church House, Great Smith Street, London, S.W.1 (Hoare Memorial Hall).*

Discussion of Scientific Papers:

2.30 p.m. (1) "Precipitation Effects in Liquid Aluminium Alloys: Experiments with a Pulsed Electronic Technique", by N. D. G. Mountford and R. Calvert (Serial No. 1953; Nov., 1959).

3.45 p.m. approx. (2) "The Embrittlement of Aluminium–Magnesium Alloys by Sodium", by C. E. Ransley and D. E. J. Talbot (Serial No. 1958; Dec., 1959).

Evening

Location: *Church House, Great Smith Street, London, S.W.1 (Hoare Memorial Hall).*

6.30 p.m. *May Lecture* by Professor P. M. S. BLACKETT, M.A., Hon. D.Sc., Hon. LL.D., F.R.S., on "The Magnetism of Rocks and Continental Drift".

It has been known for a long time that many recent rocks are magnetized roughly in the direction of the Earth's field. However, it has recently been found that rocks older than, say, 100 million years are magnetized at angles markedly different from the Earth's present field. This could be explained either by assuming that the Earth's field deviated in ancient times very greatly from that of a dipole or, alternatively, that the continents have drifted relatively from each other. The arguments for and against these two hypotheses will be discussed in detail, and the conclusion will be reached that, on balance, the evidence is in favour of continental drift.

8 for 8.15 p.m. Council Dinner in honour of the May Lecturer.

Wednesday, 30 March

Morning

Location: *Church House, Great Smith Street, London, S.W.1 (Hoare Memorial Hall).*

10.0 a.m. *Volume Increases in Fissile Materials on Neutron Irradiation*, with particular reference to a paper on:

"Volume Increases in Fissile Materials on Neutron Irradiation and the Effects of Thermal Fluctuations", by G. W. Greenwood (Serial No. 1939; Sept., 1959).

A discussion arranged by the Nuclear Energy Committee.

Afternoon

PROGRAMME "A"

Location: *Church House, Great Smith Street, London, S.W.1 (Hoare Memorial Hall).*

2.30 p.m. *New Aspects of the Electron Theory of Metals:*

An educational session arranged by the Metal Physics Committee, consisting of a series of short lectures, to be followed by questions, by:

(1) Dr. W. M. LOMER, who will give a general survey.

(2) Dr. V. HEINE on recent experimental work.

(3) Dr. J. FRIEDEL on the electron structure of alloys.

Metallurgists are familiar with the basic ideas of the electron theory of metals, as laid down in the period 1920–1940, and with the application of these ideas to the understanding of the structures and compositions of certain alloy phases, e.g. electro-compounds. The extension of this work to alloys of transitional and other more complex metals has proved less fruitful, however, and there are now doubts about whether one should continue trying to understand this wider range of alloys by more intensely applying the same ideas, or whether the present difficulties indicate some basic weakness in that approach, in which case an entirely new approach may be needed.

The dilemma has been sharpened by the intense questioning of the fundamental theory and by the new points of view that have appeared in recent years. The difference between metals and insulators is now thought to depend on the ionizability of atoms rather than on the filling of Brillouin zones. Experiments have proved that the Fermi surface, which is not supposed in the old theory to touch the Brillouin zone boundary until the limit of the alpha phase is reached in copper alloys, in fact already touches it in pure copper; this appears to strike at the whole basis of the electron theory of alloys. New ideas have emerged in recent years about the state of valence electrons round alloy atoms in metals, about the behaviour of the free electrons as an "oscillating plasma", about the electronic structure of transition metals, and about the nature of valence bonds in solids.

It is thus a very timely moment for metallurgists to ask what are the changes now taking place in the basic theory, what new features are likely to emerge, how much is likely to remain of the old theory, and in what directions should one attempt to go forward now to gain a better understanding of alloying behaviour. These are the questions which it is hoped will be answered at this meeting.

PROGRAMME "B"

2.30 p.m. *Visit* to the Victoria and Albert Museum.

A series of three (alternative) tours, accompanied by Guide Lecturers. Members and their guests are requested to arrive promptly at the main entrance to the museum at 2.30 p.m.

The subjects of the three tours will be: (1) Costume and Jewellery. (2) The English House. (3) English Painting.

Copies of the "Victoria and Albert Museum Guide" (126 pp.) are obtainable from H.M. Stationery Office, York House, Kingsway, London, W.C.2, price 2*s.* 10*d.*, post free.

No arrangements have been made for tea, but those who desire it at the conclusion of the visit are recommended to the Hotel Rembrandt close to the museum, on the opposite side of the road.

Though no charge is being made for this visit, tickets will be required. If any ticket holders are prevented from attending, it is particularly requested that—out of courtesy to the organizers—the Secretary shall be advised in advance.

Evening

Location: *17 Belgrave Square, London, S.W.1.*

7.30 to 10.30 p.m. *Conversazione and Exhibition.* The President will receive members and their guests from 7.30 to 8 p.m.

About 50 exhibits have been promised for this conversazione. Offers of others should be sent to the Secretary as soon as possible, with details of the table space, wall space, and electrical points that would be required.

The string orchestra of the Royal Regiment of Artillery will play during the evening. There will be a licensed bar.

Dress: Informal. Tickets, price 10*s.*, inclusive of coffee and light refreshments. Ladies and other guests will be welcome.

Thursday, 31 March

Morning

Location: *Church House, Great Smith Street, London, S.W.1.*

PROGRAMME "A"

Hoare Memorial Hall.

10.0 a.m. *Rolling Hard Materials in Thin Gauges.* A discussion arranged by the Metallurgical Engineering Committee and based on the following papers published, or to be published, in the *Journal:*

(1) "Rolling Hard Materials in Thin Gauges: Basic Considerations", by H. Ford and J. M. Alexander (Serial No. 1966; Jan., 1960).

(2) "The Rolling of Thin Titanium Strip", by R. J. Wilcox and P. W. Whitton (Serial No. 1967; Jan., 1960).

(3) "Rolling Aluminium Foil: An Experimental Study on a Modern Mill", by Y. Yokote and S. Nomura (Serial No. 1977; Feb., 1960).

(4) "Some Experiences in Cold Rolling Thin Alloy Strip", by H. H. Scholefield, J. E. Riley, E. C. Larkman, and D. W. Collins (Serial No. 1985; Mar., 1960).

PROGRAMME "B"

Convocation Hall.

10.0 a.m. *Vacancies, Ageing, and Precipitation.* A discussion based on the following papers published, or to be published, in the *Journal:*

(1) " The Effect of Specimen Size on the Quench-Ageing of an Aluminium–3·8% Copper Alloy ", by V. Prakash and K. M. Entwistle (Serial No. 1909; Apr., 1959).
(2) " Quench-Ageing in Annealed Lead ", by E. J. Hooker (Serial No. 1941; Sept., 1959).
(3) " Clustered Vacancy Defects in Some Face-Centred Cubic Metals and Alloys ", by R. E. Smallman, K. H. Westmacott, and J. H. Coiley (Serial No. 1954; Nov., 1959).
(4) " Hardness Changes in Cold-Worked Aluminium Alloys During Short Ageing Treatments ", by N. Gane and R. N. Parkins (Serial No. 1962; Dec., 1959).
(5) " The Effect of Structural Imperfections on the Age-Hardening of Aluminium–Zinc Alloys ", by R. D. Garwood and A. L. Davies (Serial No. 1989; Mar., 1960).

Afternoon

Location: *Church House, Great Smith Street, London, S.W.1. (Hoare Memorial Hall).*

2.30 p.m. Discussion on " Rolling Hard Materials in Thin Gauges ", continued.

3.30 p.m. approx. Discussion on the following paper, published in the *Journal:*

" Resistance to Deformation of Aluminium and Some Aluminium Alloys: Its Dependence on Temperature and Rate of Deformation ", by R. R. Arnold and R. J. Parker (Serial No. 1978; Feb., 1960).

Evening

Location: *Great Room, Grosvenor House, Park Lane, London, W.1.*

7.0 for 7.30 p.m. *Annual Dinner.* *Principal Guest:* The Prime Minister (The Right Hon. HAROLD MACMILLAN, P.C., M.P.), who will propose the toast of " The Institute of Metals and the Non-Ferrous Metal Industries ".

Tickets, price 45*s.*, including coffee, but not drinks.

Dress: Evening dress or uniform, with decorations.

Tables may be reserved for parties of 8 to 12; individuals and smaller parties will, so far as is practicable, be accommodated with friends in accordance with requests submitted in writing. Although bookings will be accepted up to a few days before the dinner, inclusion of names in the dinner plan cannot be guaranteed after 22 March.

At the conclusion of the dinner, there will be dancing to Sidney Lipton's orchestra until 1 a.m.

Instructional Meetings for Younger Members

The instructional meeting on " Preheating and Hot-Rolling Practice ", which was being planned for this year, has had to be postponed until 1961. The main reason for this is that new plant is being installed at one of the works it is proposed to visit. Those taking part in the meeting in 1961 will accordingly have the opportunity to inspect a completely up-to-date plant.

Efforts are being made to arrange an alternative meeting this year, and if these are successful an announcement will be made as soon as possible in the *Bulletin.* In addition, all Student and Junior Members will receive individual notification.

Discussions at the Spring Meeting

Among the technical discussions arranged to take place during the Spring Meeting, to be held as already announced from Tuesday to Thursday, 29–31 March, are two of particular interest and importance to industrial metallurgists.

Sounder Aluminium Alloy Castings

On the Tuesday afternoon, the first paper to be discussed is by N. D. G. Mountford and R. Calvert, of the Aero-Engine Division of Rolls-Royce Ltd., Derby. This paper, " Precipitation Effects in Liquid Aluminium Alloys ", published in the November 1959 Journal, describes the use of an ultrasonic technique to investigate oxide films and other impurities in aluminium alloy melts. The work has resulted in the development of a modified melting technique giving better quality melts for casting, and it is suggested that the same method could possibly be used to explore the general cleanliness of copper alloys, cast irons, or even steels.

Embrittlement of Aluminium Alloys by Sodium

It has been known for some time that aluminium alloys in which magnesium is the major alloying element are prone to brittle behaviour in hot working when contaminated with traces of sodium either derived from the virgin aluminium or picked up from fluxes used in melting. Certain of these alloys can be very troublesome in production unless suitable precautions are taken. The second paper to be discussed on the Tuesday afternoon, by C. E. Ransley and D. E. J. Talbot of the Research Laboratories of The British Aluminium Co. Ltd., describes an investigation of the constitutional factors involved and the mechanism of the embrittlement process. This paper appeared in the December 1959 Journal.

Rolling Thin Strip

On Thursday March 31 a whole-day discussion has been arranged by the Metallurgical Engineering Committee on the rolling of hard materials in thin gauges, based upon four invited papers. The discussion will be opened with a paper by Professor H. Ford and J. M. Alexander, published in the January 1960 Journal, on " Rolling Hard Materials in Thin Gauges: Basic Considerations ", in the course of which a new basis is proposed for calculating the minimum thickness that it is possible to roll. Following this comes a paper by R. J. Wilcox and P. W. Whitton of Imperial Chemical Industries Ltd., Metals Division, on " The Rolling of Thin Titanium Strip ", also published in the January 1960 Journal, in which it is shown that considerable scope exists for extending the usefulness of conventional mills for rolling thin hard sheet by careful choice of lubricant.

The third paper, by Y. Yokote and S. Nomura, comes from Japan and describes investigations carried out on a modern high-speed four-high foil mill, the first to be built in that country, installed by the Shibaura United Engineering Co. Ltd., Tokyo; it is published in this issue of the Journal.

The remaining paper in this group, to be published in the March Journal, is by H. H. Scholefield and three of his colleagues at Telegraph Construction and Maintenance Co. Ltd., and describes experiences, principally on a Sendzimir mill, in the cold rolling of thin strip in nickel-iron alloys and beryllium copper.

PERSONAL NOTES

Dr. E. A. Calnan has left the Fulmer Research Institute to become Director of Research with Gillette Industries, Ltd., Reading.

Mr. D. F. Campbell has been appointed President of the Metallurgical Equipment Export Company.

Mr. C. G. Clow has left the Research Laboratories of The General Electric Company, Ltd., and taken up an appointment as metallurgist with Constructors John Brown, Ltd., London.

Dr. A. L. Davies has left the Parkinson Cowan Group to become a lecturer in metallurgy at the Birmingham College of Advanced Technology.

Dr. W. A. Dean has been appointed Assistant Director of Research of the Aluminum Company of America, New Kensington, Pa. He succeeds Mr. W. T. Ennor, who has retired.

Mr. G. A. Dummett, Research Director of the A.P.V. Company, Ltd., has been appointed Chairman of the Industrial Research Committee of the Federation of British Industries.

Mr. H. B. Grainger has been appointed Technical Manager of Imperial Aluminium Co., Ltd., Waunarlwydd Works, Swansea. He was formerly head of the aluminium section of the Research Department of Imperial Chemical Industries, Ltd., Metals Division, Birmingham.

Mr. R. Kauffmann has been appointed General Manager of Camea, Buenos Aires.

Dr. S. Mocarski has left the Ford Motor Company of Canada, Ltd., and joined the Canadian General Electric Co., Ltd., Civilian Atomic Power Department, Peterborough, Ont., as Metallurgical Engineer.

Dr. J. G. Pearce has been appointed a Consultant to the Alloys Division of Union Carbide, Ltd., London.

Mr. G. A. Pickup has left the U.K. Atomic Energy Authority to become a lecturer in metallurgy at the Manchester College of Technology.

Dr. Carl H. Samans, Associate Director of the Engineering Research Department, Standard Oil Company (Indiana), has been elected a National Trustee of the American Society for Metals for a two-year term.

Mr. D. Thacker has been appointed Head of the Department of Science at the Sheffield College of Technology.

Mr. E. Weiss, Managing Director of Foundry Services International, Ltd., has been appointed Chairman of the Company.

Deaths

The Editor regrets to announce the deaths of:

Mr. Herbert Spencer Stanley Murray, until recently Managing Director of Electro-Platers, Ltd., Glasgow, on 8 January 1960. Mr. Murray was elected Chairman of the Scottish Local Section only last year.

Mr. George Thomas Whitehouse, Chairman and Joint Managing Director of Metal Products Co. (Willenhall), Ltd., and Chairman of Willenhall Reclamation Co. He was a Past-President of the British Bronze and Brass Ingot Manufacturers' Association.

LETTER TO THE EDITOR

The Effect of Purity on Conclusions Drawn from Creep Data

It has been suggested [1] that in the climb model of creep, a high density of dislocation jogs must be assumed. This may be obtained either by many dislocations with widely spaced jogs or by few dislocations with many jogs. It is reasonable to expect that the high jog energies associated with metals of low stacking-fault energy will result in widely separated jogs, so that more dislocations will be necessary to provide the requisite jog density. McLean [1] has suggested that one possible means of comparing dislocation densities may be the stress necessary to obtain a specified creep rate at comparable temperatures, expressed as a fraction of the shear modulus. Using the data of Weertman and Shahinian [2] for 99·75% nickel and those of Dorn [3] for 99·987% aluminium, McLean calculated that it requires 1/2400th of the shear modulus to produce a creep rate of 10^{-6} sec^{-1} at 204° C in aluminium, whilst to produce the same creep rate at 642° C in nickel requires 1/1000th of the shear modulus. If this comparison is valid, it would indicate a higher dislocation density in nickel than in aluminium.

However, recent data obtained in this laboratory on 99·98% nickel of grain size comparable to that of the aluminium shows that the stress required to produce a creep rate of 3×10^{-6} sec^{-1} at 600° C is 1/2400th of the shear modulus, whilst to produce the same creep rate at 182° C in aluminium requires 1/1730th of the shear modulus. This result is almost the reverse of the previous calculation and indicates a lower dislocation density in nickel.

From the known data on nickel it is possible to consider the effect of purity on creep rate. The stresses necessary to produce a creep rate of 3×10^{-6} sec^{-1} at 600° C in 99·75 [2], 99·98, and better than 99·99% [4] nickel are 1/760th, 1/2400th, and 1/2610th of the shear modulus, respectively. These calculations illustrate the importance of using materials of the highest possible purity in fundamental creep investigations.

If the proposed method of estimating dislocation densities is valid, then the above calculations indicate that under comparable conditions the same creep rate can be obtained in nickel with a lower jog content than in aluminium. On the climb model for creep this can be accounted for only by much more rapid jog movement and hence a faster diffusion rate in aluminium. Although a long-life isotope of aluminium has recently been reported,[5, 6] a reliable experimental value for the self-diffusion coefficient has not yet been obtained. However, two theoretical expressions have been proposed; one by Le Claire [7] gives a value for aluminium at 182° C of $10^{-20·5}$, whilst the other, by Nowick,[8] gives a value of $10^{-16·1}$. The self-diffusion coefficient for nickel [9] at 600° C is $10^{-16·5}$. These values emphasize that the diffusion rate of aluminium, if not slower, is certainly not much greater than that of nickel.

Thus it appears that jog movement in aluminium is not more rapid than in nickel and, if the initial assumptions [1] are correct, this suggests that climb may not be the rate-controlling process in the high-temperature creep of nickel.

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LECTURES TO LOCAL SECTIONS AND ASSOCIATED SOCIETIES

The Continuous Casting of Bronze

At a meeting of the Scottish Local Section on 23 November 1959, Professor E. C. Ellwood, of the Department of Metallurgy, Royal College of Science and Technology, Glasgow, gave a lecture on "The Continuous Casting of Bronze". The meeting was attended by the President of the Institute, who was accompanied by the Secretary.

Continuous casting was defined as a method of solidifying metal in a die in such a manner that solid metal is drawn from one end of the die, while the other end is replenished by liquid metal. This definition does not indicate whether the die is vertical or horizontal, or whether the metal is poured directly into the die or the die is filled from another receptacle attached to it in such a way that the liquid metal is continuous between the receptacle and the die. Indeed, all these methods are possible.

Continuous casting offers several advantages. The zone over which solidification takes place, at least in the case of non-ferrous metals, is small, and the interdendritic paths through which feed metal flows are relatively short and thus shrinkage porosity is largely avoided. Similarly, with a shallow solidification front bubbles of gas released during solidification escape, and gas porosity is also very largely eliminated.

The cast material can be obtained in long lengths which are suitable for machining on automatic lathes, or alternatively considerable lengths and weights may be produced for subsequent working at sizes much closer to the finished size, thus reducing the amount of mechanical working required to make the final product. A limitation of continuous casting is that the product must be of uniform cross-section, although the cross-section need not be of simple shape.

In considering the continuous casting of bronze, it is necessary to take into account the market demands. Bronze is required for the manufacture of bushes in a wide variety of sizes, but the number of large bushes produced is such that it may not be worth while setting up a continuous-casting machine to produce material for them. In general, it is economic to set up a machine only for the production of sizes of less than about 3 in. dia., for which orders for hundreds or thousands of feet may be forthcoming. The smallest size normally cast is about $\frac{1}{2}$ in. dia. Since the greater part of the bronze is required for bushes, there is a demand for cored rods or tubes with a wall thickness down to $\frac{3}{16}$ in., and a successful continuous-casting process should be able to make these. It is extremely difficult to pour bronze into an annulus $\frac{3}{16}$ in. wide or into a die small enough to produce rods of $\frac{1}{2}$ in. dia. Therefore, it is desirable to use some method of closed casting in which the die is fed from a reservoir considerably larger in diameter than the die orifice. If the closed method of casting is used part of the die at least is in contact with liquid metal before solidification. Liquid bronze is liable to attack all known metals and therefore a non-metallic die is required.

Normally, refractory materials have too low a thermal conductivity to be used for the die, and there is also some difficulty in obtaining smooth surfaces and accurate sizes. The obvious choice of non-metallic die material is therefore graphite, which has a reasonable thermal conductivity, high refractoriness and resistance to thermal shock, and good machining qualities. The successful methods for the continuous casting of bronze in small sizes are based on the closed method of casting, using a graphite die.

Proposals along these lines were made first in 1932, and the use of a graphite mandrel for the production of tubes was suggested in 1936. In the meantime, Junghans in Germany had succeeded in casting bronze in sizes of about 5 in. dia. using a metal die. The Junghans process was described, and this was followed by an account of the Asarco process, which was the first to be used for large-scale production purposes.

The remainder of the lecture was concerned with the work of Ellwood, Prytherch, and Phelps, which was described in the *Journal of the Institute of Metals*, 1955–56, **84**, 319.

Recent Corrosion Studies in Titanium

Mr. J. B. Cotton, of the Research Department, Imperial Chemical Industries, Ltd., Metals Division, lectured on the corrosion of titanium to the Birmingham Local Section at its meeting on 12 November 1959.

The subject was introduced by an indication of the importance of surface films in conferring resistance to corrosion upon many metals. It was pointed out that much detailed study had been made of rates of growth and constitution of such films, but that there was scope for further investigation concerning the mechanism by which surface films were bound to the metal surface, the physical chemistry of metal–solute systems, and the necessity of elucidating the fundamental mechanism involved in breakdown at passive surfaces.

The onset and breakdown of passivity in titanium was demonstrated by reference to an electrical potential/time graph, and the superior behaviour of titanium over stainless steel under borderline passivating conditions, in *aqua regia*, was shown by reference to specimens in the form of pump impellers.

The behaviour of titanium in non-oxidizing acids was discussed in relation to a Pourbaix diagram, and it was pointed out that by raising the electrical potential of titanium it should be possible to force the formation of insoluble TiO_2.

That this could, in fact, be done with titanium immersed in hot strong sulphuric acid was demonstrated by reference to polarization curves, constructed by holding the potentials of specimens at pre-selected levels by means of a potentiostat. The facility with which titanium can be induced to passivate anodically in reducing acids was illustrated by a short colour film showing the growth of the passive layer, and this was

followed by a slide indicating the wide range of non-oxidizing acids in which the effect operated.

That anodic passivation of titanium was likely to be of practical use to chemical engineers was shown in a series of slides of a pilot plant constructed entirely of titanium and used to circulate 40% sulphuric acid at 60° C. Corrosion in this system, which would otherwise have progressed at the rate of about 1 in./year, was completely halted by imposition of an anodic d.c. potential of 2–3 V, current consumption being of the order of $3W/10^3$ ft^2.

The passive film built up by anodic polarization persisted for appreciable periods of time even after the protective potential was cut off and its behaviour was still under investigation. It was pointed out that there were close similarities between this feature and that observed by J. S. Llewelyn Leach in respect of behaviour of uranium in alkaline solutions (*J. Inst. Metals*, 1959–60, **88**, 24).

The mechanism of the bonding of titanium dioxide to the metal surface was discussed by reference to American and Japanese work, but as yet it was not possible to state with any certainty the mechanism involved. Nevertheless, in spite of the vast amount of investigation already devoted to protective films, the subject appeared to have entered a most interesting phase.

Corrosion and Microstructure

On 11 December 1959, Dr. C. EDELEANU, of the Tube Investments Research Laboratories, spoke on "Corrosion and Microstructure" to the Southampton Metallurgical Society.

He said that the corrosion-resistance of alloys depended on composition, and the metallographer to some extent made use of this fact to reveal structural features by etching. In corrosion, which after all was only a prolonged type of etching, the presence of second phases, precipitates, and other such matters were of prime importance, and failures such as intercrystalline corrosion and selective attack were the consequence of the use of metals with unsuitable structure.

There was now good reason to expect that apart from these important gross structural effects, structure on the atomic scale was also important in corrosion, but the subject had not yet been studied extensively. The low overpotential of the anodic reaction, which imposed severe limitations on the use of metals, was in all probability due to the presence of steps on metal surfaces and these in turn were due to the presence of dislocations. Even with film-covered metal it was known that dislocations could be important, since in many cases it had been possible to etch them up, though exactly how this occurred was still a matter of debate. In many cases it seemed that impurities in the metals which might concentrate at dislocations might be involved, but recent work had shown that the damage to the film due to the movement of dislocations was also an important factor.

The most important corrosion phenomenon, which would not be fully interpretable without introducing metal physics, was stress-corrosion, since in this case the rate of propagation of cracks was very high for a straightforward corrosion reaction, though low by purely physical standards. Work on brass had shown that the process might involve a corrosion-induced local mechanical failure. The crack progressed in short rapid bursts, being held up by slip, and the slow stage in the cycle seemed to be the chemical reinitiation of this mechanical cracking.

POWDER METALLURGY JOINT GROUP

Informal Discussion on "Direct Rolling Processes in Powder Metallurgy"

The next meeting of the Powder Metallurgy Joint Group will be held in the Hoare Memorial Hall, Church House, Great Smith Street, London, S.W.1, on Tuesday, 12 April 1960 (not on 11 and 12 April, as previously notified).

Three of the papers on which this discussion will be based have already been published in *Powder Metallurgy*, 1958, No. **3**; the remaining four papers will be printed in No. **5** (1960), which is due for distribution to subscribers in March. Visitors will be welcome at the meeting, for which tickets are not required.

Programme

10.30 a.m. to 12.30 p.m. — Presentation and discussion of the following papers to be published (all in *Powder Metallurgy*, No. **5**, 1960):

(1) MARSHALL: "Some Mechanical Requirements of Plant for the Roll Compacting Process".

(2) DIEBEL, THORNBURG, and EMLEY: "Continuous Compaction by Cyclic Pressing".

(3) FORRESTER and BEDDOW: "Continuous Sintering of Copper–Lead to Steel".

2.30 to 5.0 p.m. — Presentation and discussion of the following papers (Nos. 4, 5, and 6 were printed in *Powder Metallurgy*, 1959, No. **3**; No. 7 will be published in *Powder Metallurgy*, 1960, No. **5**):

(4) EVANS and SMITH: "The Compaction of Metal Powders by Rolling. I.—The Properties of Strip Rolled from Copper Powders".

(5) EVANS and SMITH: "The Compaction of Metal Powders by Rolling. II.—An Examination of the Compaction Process".

(6) WORN and PERKS: "Production of Pure Nickel Strip by the Direct-Rolling Process".

(7) HUNT and EBORALL: "The Rolling of Copper Strip from Hydrogen-Reduced and Other Powders".

5.30 p.m. approx. — *Cocktail Party* in the Bishop Partridge Hall at Church House (Tickets price 12*s.* 6*d.* each; visitors will be welcome).

OTHER NEWS

First International Congress on Metallic Corrosion

The First International Congress on Metallic Corrosion, which is intended to cover the broad field of corrosion under the following headings, will be held in the Imperial College of Science and Technology in London from 10 to 15 April, 1961:

I. Corrosion principles and fundamentals.
II. Papers primarily relating to particular metals.

III. Papers primarily relating to particular environments:
   1. Atmosphere.
   2. Water.
   3. Soil.
   4. Other media.
   5. High temperature.

IV. Papers relating to methods of protection:
   1. Metallic coatings.
   2. Non-metallic coatings.
   3. Inhibitors.
   4. Cathodic protection.
   5. Other methods.

V. General papers (dealing with an industry and covering a range of metals, media, and preventive measures).

VI. Economics and design.

VII. Methods of testing.

VIII. Education, &c.

The scientific programme is being organized by a special committee under the Chairmanship of Mr. L. Kenworthy, Chairman of the Corrosion Group of the Society of Chemical Industry.

Full details of the programme, including works' visits and social events, will be published later, but in the meantime forms of application for membership of the Congress (registration fee £5) are available from the Hon. Secretary of the Congress, F. C. Griffin, 14 Belgrave Square, London, S.W.1.

Société Française de Métallurgie

The 1960 Autumn Meeting of the Société Française de Métallurgie will be held on 17–21 October at the Maison de la Chimie, 28 bis, rue Saint-Dominique, Paris (7ème).

The main subject of the meeting will be "The Heat-Treatment of Metals and Alloys", though papers on other aspects of metallurgy will also be accepted. Anyone wishing to offer a paper should inform the Secretary of the Société Française de Métallurgie, 25, rue de Clichy, Paris (9ème), before 1 April and should submit a summary (500–1000 words in French, English, or German) in duplicate not later than 1 July 1960.

A programme containing details of the various sessions and summaries of the papers to be presented will be ready in September.

Symposium on the Use of Aluminium in Railway Rolling Stock

A Symposium on "The Use of Aluminium in Railway Rolling Stock" will be held by the Institution of Locomotive Engineers and the Aluminium Development Association on Friday, 27 May 1960, in London. The Symposium will comprise two sessions: a morning session, in which five papers on design and construction of aluminium railway rolling stock will be introduced and discussed, and an afternoon session comprising eight papers on operation and service experience with aluminium railway rolling stock.

The Symposium will be held at the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1, from 10.0 a.m. until 5.0 p.m., and members of the Institution of Locomotive Engineers and of the Aluminium Development Association and visitors will be admitted by ticket, for which there will be a registration fee of £1 per person. The registration fee will entitle the participants to a full set of the preprints of the papers and the subsequent bound proceedings of the Symposium.

1960 Microscopy Symposium

The 1960 National Microscopy Symposium will be held at the Del Prado Hotel in Chicago on 13–15 June. Sessions will cover (1) instrumentation, (2) methods and techniques, and (3) applications. Short papers in all fields of light, electron, and X-ray microscopy are solicited for presentation. Inquiries should be addressed to the sponsor, Walter C. McCrone Associates, 501 East 32nd Street, Chicago 16, Illinois.

The programme will, as in the past, emphasize informality and audience participation. Formal presentations will be short and woven into the discussion by a panel of experts conducting the sessions. The emphasis this year is on the microscope as a tool in all sciences.

Refresher Course for Older Graduates

The Department of Metallurgy, Battersea College of Technology, S.W.11, has organised a number of refresher courses for older graduates to be given at the College during the Easter and Summer Vacations in the current session. The courses will last 3–4 days and will be given by members of the College staff and visiting lecturers.

The first courses planned will be as follows:

"The Structure of Metals and Alloys"	Easter Vacation, April 1960.
"Developments in Foundry Practice"	Summer Vacation, July 1960.
"Austenite Transformation—The Present Position"	Summer Vacation, September 1960.

The courses are intended for metallurgists who, having completed their academic studies some years ago, may now like to survey the present state of knowledge in fields additional to their own speciality.

DIARY

Powder Metallurgy Joint Group

12 April. Symposium on "Direct Rolling Processes in Powder Metallurgy", Hoare Memorial Hall, Church House, Great Smith Street, London, S.W.1. (Three of the papers for this meeting were published in *Powder Metallurgy*, 1959, No. 3; the remaining papers will be published in advance in *Powder Metallurgy*, 1960, No. 5.)

Local Sections and Associated Societies

5 April. Oxford Local Section. Annual General Meeting, followed by "Low-Temperature Properties of Metals", by Dr. H. M. Rosenberg. (Cadena Café, Cornmarket Street, Oxford, at 7.0 p.m.)

7 April. London Local Section. Annual General Meeting, followed by a Symposium on "Metallographic Techniques". (17 Belgrave Square, London, S.W.1, at 6.0 p.m.)

7 April. Leeds Metallurgical Society. "Metallurgical Research in the Department of Scientific and Industrial Research", by Dr. N. P. Allen. (University Staff House, University Road, Leeds, at 6.30 p.m.)

7 April. Liverpool Metallurgical Society. "The Examination of Irradiated Elements", by Dr. G. B. Greenough, followed by the Twelfth Annual General Meeting. (The Library, Department of Metallurgy, University of Liverpool, 146 Brownlow Hill, Liverpool 3, at 7.0 p.m.)

7 April. Sheffield Local Section. Annual General Meeting. (Applied Science Building, The University, St. George's Square, Sheffield 1, at 7.30 p.m.)

14 April. East Midlands Metallurgical Society. Annual General Meeting, followed by "Reactor Metallurgy". (School of Art, Green Lane, Derby, at 7.30 p.m.)

APPOINTMENTS VACANT

A SPECTROSCOPIST

is required at the ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, to assist in developing spectroscopic techniques applied to the study of ATOMIC SPECTRA in the TRANSURANIC ELEMENTS.

Work includes:

STUDY OF ISOTOPE SHIFTS.
EMISSION SPECTRA in visible and near INFRA RED regions by both photographic and recording techniques.
DEVELOPMENT OF NEW TYPES OF SOURCES.

There is ample opportunity to take part in research work of a non-routine nature in a well-equipped general spectroscopy group.

Salary: £510 (at age 20)–£1285 p.a. according to age and experience.

Applicants should have G.C.E. at "A" level, H.N.C., or equivalent.

Practical or theoretical knowledge of spectroscopic techniques and a pass degree (with chemistry or physics as one subject) would be an advantage.

Housing and pension scheme.

Please send POST CARD to the Group Recruitment Officer (1573/233), U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Didcot, Berks.

ALUMINIUM LABORATORIES LIMITED

Applications are invited from QUALIFIED METALLURGISTS to fill a vacancy in the WROUGHT AND PHYSICAL METALLURGY SECTION of the METALLURGY DIVISION of these LABORATORIES. The work involved is varied, so that the selected candidate will be able to obtain a wide experience. This post provides an excellent opportunity and should appeal to the 25–30 age group. The commencing salary will be according to age, qualifications, and experience, whilst promotion will be entirely on merit. A generous Life Assurance and Pension Scheme is in operation. Applicants should write, giving brief personal details, to: The Personnel Officer, Aluminium Laboratories Limited, Banbury, Oxon.

ENGLISH ELECTRIC

invite applications from

METALLURGISTS & CHEMISTS

for an appointment involving investigations on the high-temperature corrosion of reactor materials.

A degree or its equivalent is necessary for this appointment and some experience in this field would be an advantage although not essential.

The appointment is permanent and pensionable. Assistance can be given towards house purchase.

Applications (which will be treated in strictest confidence) giving details of qualifications, experience, and current salary should be addressed to:—Dept. C.P.S., Marconi House, 336/7 Strand, London, W.C.2 quoting reference 1814Q.

MINISTRY OF AVIATION requires TECHNICIAN at the Aeronautical Inspection Directorate, Harefield, Middx., to assist in the metallographic investigation of defects and failures. Quals.: Recognized engineering apprenticeship or suitable training, followed by several years in a metallurgical laboratory. Experience in the metallography of either high quality steels or aluminium alloys. O.N.C., C. & G. Final Certificates, or equiv. *Salary* £900 (age 30)–£1,065 p.a. Application forms from Manager (P.E. 2051), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4.

METALLURGIST

Non-ferrous metal manufacturers in S.W. Lancashire require an additional Graduate Metallurgist in their process control department. Industrial experience is not essential providing the candidate possesses the personal qualities and ability required to work as a member of a small enthusiastic team. This is a staff appointment and a superannuation scheme is in operation.

Full details with application to
Box No. 452, Institute of Metals, 17 Belgrave Square, London, S.W.1.

ST. EDMUND HALL, OXFORD

Isaac Wolfson Research Fellowship in Metallurgy

Applications are invited for the Isaac Wolfson Research Fellowship in Metallurgy. Candidates, who should be suitably qualified graduates aged 24–35, may be either British subjects (from any Commonwealth country) or Israeli citizens. The appointment will date from 1 October and will be for three years. The Fellow will be expected to carry out research in a field approved by the Isaac Wolfson Professor. Stipend will be £800–1,000 plus F.S.S.U. The Fellow will be entitled to certain meals free of charge and either free accommodation in college or housing allowance, and if resident abroad will be assisted in whole or in part with his travelling expenses.

Applications (in triplicate) should be sent to The Principal, St. Edmund Hall, Oxford, on or before 23 April. Candidates should submit a detailed statement of career to date and of the research proposed, together with the names of two referees.

TIN RESEARCH INSTITUTE

PHYSICAL METALLURGIST with honours degree or Dip.Tech. is required in the Metallurgy Department of the Tin Research Institute. Post-graduate experience is not essential, but preference would be given to a man with some research experience in one of the following fields:—tracer techniques, ferrous metallurgy, the "newer" metals. Publication of researches is encouraged and opportunity exists for the submission of work for higher degrees. Starting salary will be dependent on qualifications and experience. The position carries F.S.S.U. benefits. Applications to the Director, Tin Research Institute, Fraser Road, Greenford, Middlesex.

UNIVERSITY OF CAMBRIDGE

Applications are invited for a University Demonstratorship in Metallurgy to hold office from 1.10.60. Applications will close on 31.3.60.

Details of duties, salary, &c., may be obtained from Dr. F. B. Kipping, University Chemical Laboratory, Lensfield Road, Cambridge,

APPOINTMENT REQUIRED

METALLURGICAL ENGINEER, honours graduate with extensive experience of research, development, and modern production practice and administration up to and including management level in non-ferrous tube manufacture, seeks position in this or associated industry. Box No. 451, Institute of Metals, 17 Belgrave Square, London, S.W.1.